

CLAIMS

1. A method of providing a change of pressure between two pressure states: a low pressure state and a high pressure state of at least 4000 bar, in a pressure vessel of a high pressure isostatic pressing device in which a liquid pressure medium is used for generating the pressure, the method comprising the steps of:

transferring liquid pressure medium between a first pressure changing means and the pressure vessel, thereby changing the pressure in the pressure vessel from one of said two pressure states to an intermediate pressure state which has a value in between the pressures of the two pressure states; and

transferring liquid pressure medium between a second pressure changing means and the pressure vessel, thereby changing the pressure in the pressure vessel from said intermediate pressure state to the other one of said two pressure states.

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2. The method as claimed in claim 1, for changing the pressure in the pressure vessel from the low pressure state to the high pressure state, wherein

the first pressure changing means is used for feeding the liquid pressure medium into the pressure vessel, and for pressurising the liquid pressure medium so that the pressure vessel is subjected to said intermediate pressure being lower than the high pressure, and wherein

the second pressure changing means is used for intensifying the pressure of the liquid pressure medium so that the pressure in the pressure vessel is increased from said intermediate pressure state to the high pressure state.

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3. The method as claimed in claim 2, in which the pressure vessel and the second pressure changing means

are arranged in fluid communication with each other, wherein the act of feeding the liquid pressure medium includes bleeding a portion thereof from the pressure vessel into the second pressure changing means.

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4. The method as claimed in claim 3, in which the act of intensifying includes the step of forcing bled liquid pressure medium to return into the pressure vessel, while preventing such liquid pressure medium  
10 which is already inside the pressure vessel from escaping therefrom.

5. The method as claimed in claim 4, in which said step of forcing is performed in a single stroke,  
15 preferably by driving a piston of a single-stroke intensifier in a direction from a low pressure side to a high pressure side thereof.

6. The method as claimed in claim 4, in which said  
20 second pressure changing means comprises at least two intensifier devices, wherein, for each of the intensifier devices, the step of forcing is performed in a single stroke, preferably by driving a piston of a single-stroke intensifier from a low pressure side to a high pressure  
25 side thereof.

7. The method as claimed in any one of claims 2-5, in which the pressure vessel and the second pressure changing means are included in a single-stroke  
30 intensifier comprising a high pressure chamber in which a piston is movable between a retracted position and an advanced position, the pressure vessel comprising a first portion of said high pressure chamber extending from the piston when being in its advanced position to an opposing  
35 end of the high pressure chamber wall, the second pressure changing means comprising a second portion of

said high pressure chamber extending from the retracted position to the advanced position of the piston.

8. The method as claimed in claim 1, for changing  
5 the pressure in the pressure vessel from the high pressure state to the low pressure state, such as after a pressing operation, comprising the steps of:

withdrawing part of the liquid pressure medium from the pressure vessel to the first pressure changing means  
10 so that the pressure in the pressure vessel is lowered to said intermediate pressure; and

releasing the rest of the liquid pressure medium from the pressure vessel to the second pressure changing means so that the pressure in the pressure vessel is  
15 decreased from said intermediate pressure to the low pressure.

9. The method as claimed in claim 8, in which the start of said step of releasing is followed by or  
20 performed simultaneously by a step of feeding said withdrawn part of the liquid pressure medium from the first pressure changing means via the pressure vessel to the second pressure changing means.

25 10. The method as claimed in any one of claims 8-9, in which said step of withdrawing is performed in a single stroke, preferably by driving a piston of a single-stroke intensifier from a high pressure side to a low pressure side thereof.

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11. The method as claimed in any one of claim 8-9, in which said first pressure changing means comprises at least two intensifier devices, wherein, for each of the intensifier devices, the step of withdrawing is performed  
35 in a single stroke, preferably by driving a piston of a single-stroke intensifier from a high pressure side to a low pressure side thereof.

12. The method as claimed in any one of claims 8-11, in which said second pressure changing means comprises at least one release valve.

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13. The method as claimed in any one of claims 8-10 or 12, in which the pressure vessel and the first pressure changing means are included in a single-stroke intensifier comprising a high pressure chamber in which a  
10 piston is movable between a retracted position and an advanced position, the pressure vessel comprising a first portion of said high pressure chamber extending from the piston when being in its advanced position to an opposing end of the high pressure chamber wall, the first pressure  
15 changing means comprising a second portion of said high pressure chamber extending from the advanced position to the retracted position of the piston.

14. The method as claimed in any one of claims 1-13,  
20 in which said intermediate pressure is in the order of 2000 bar to 85 % of the pressure at said high pressure state.

15. A method of operating a high pressure isostatic  
25 pressing device, comprising the step of changing the pressure in the pressure vessel from the low pressure state to the high pressure state according to any one of claim 2-8, and further comprising the subsequent steps of:

30 withdrawing part of the liquid pressure medium from the pressure vessel to the second pressure changing means so that the pressure in the pressure vessel is lowered to said intermediate pressure state; and

35 releasing the rest of the liquid pressure medium from the pressure vessel through at least one release valve so that the pressure in the pressure vessel is

decreased from said intermediate pressure state to the low pressure state.

16. A method as claimed in claim 15, in which said  
5 second pressure changing means comprises or is included in a single-stroke pressure intensifier which comprises a low pressure chamber in which a low pressure piston is axially displaceable, a high pressure chamber being arranged on one side of the low pressure chamber and  
10 coaxially therewith, a high pressure piston being secured to the low pressure piston and being arranged axially displaceable in the high pressure chamber, the method further comprising the step of:

measuring the pressure in the low pressure chamber,  
15 thereby enabling the pressure in the pressure vessel to be calculated.

17. A high pressure isostatic pressing device for operating at pressures of at least 4000 bar, comprising:  
20 a pressure vessel in which a liquid pressure medium is used for generating a pressure;  
a pressure changing arrangement for providing, in the pressure vessel, a change of pressure between two pressure states: a low pressure state and a high pressure  
25 state, the pressure changing arrangement being adapted to transfer liquid pressure medium between a first pressure changing means and the pressure vessel so that the pressure in the pressure vessel is changed from one of said pressure states to an intermediate pressure state  
30 which has a value in between the pressures of the two pressure states, and to transfer liquid pressure medium between a second pressure changing means and the pressure vessel so that the pressure in the pressure vessel is changed from said intermediate pressure state to the  
35 other one of said pressure states.

18. The high pressure pressing device as claimed in claim 17, wherein said first pressure changing means comprises a hydraulic pumping system adapted to increase the pressure in the pressure vessel from the low pressure state to the intermediate pressure state, and wherein said second pressure changing means, being in fluid communication with the pressure vessel, comprises a single-stroke intensifier adapted to increase the pressure in the pressure vessel from the intermediate pressure state to the high pressure state.

19. The high pressure pressing device as claimed in claim 18, wherein said single-stroke intensifier is further adapted to, after a pressing operation, withdraw part of the liquid pressure medium from the pressure vessel so as to decrease the pressure therein from the high pressure state to the intermediate pressure state, and wherein said pressure changing arrangement comprises at least one release valve adapted to release the rest of the liquid pressure medium from the pressure vessel so as to decrease the pressure from the intermediate pressure state to the low pressure state.

20. The high pressure pressing device as claimed in claim 17, wherein said first pressure changing means comprises a single-stroke intensifier which is adapted to withdraw part of the liquid pressure medium from the pressure vessel, thereby decreasing the pressure therein from the high pressure state to the intermediate pressure state, and wherein said second pressure changing means comprises at least one release valve adapted to release the rest of the liquid pressure medium from the pressure vessel, thereby decreasing the pressure from the intermediate pressure state to the low pressure state.

21. The high pressure pressing device as claimed in claim 23, wherein the single stroke-intensifier comprises

a low pressure chamber in which a low pressure piston is axially displaceable, a high pressure chamber being arranged on one side of the low pressure chamber and coaxially therewith, a high pressure piston being secured  
5 to the low pressure piston and being arranged axially displaceable in the high pressure chamber, wherein a draining valve is provided in communication with the low pressure chamber and may be opened so as to drain fluid  
10 from the low pressure chamber and cause said pistons to be retracted in the direction towards the low pressure chamber, thereby decreasing the pressure in the pressure vessel to the intermediate pressure state.

22. The high pressure pressing device as claimed in  
15 claim 17, wherein the pressure vessel and one of said pressure changing means are included in a single-stroke intensifier comprising a high pressure chamber in which a piston is movable between a retracted position and an advanced position, the pressure vessel comprising a first  
20 portion of said high pressure chamber extending from the piston when being in its advanced position to an opposing end of the high pressure chamber wall, the pressure changing means comprising a second portion of said high pressure chamber extending from the retracted position to  
25 the advanced position of the piston.

23. The high pressure pressing device as claimed in any one of claims 18-22, wherein the single-stroke intensifier comprises a low pressure chamber in which a  
30 low pressure piston is axially displaceable, a high pressure chamber being arranged on one side of the low pressure chamber and coaxially therewith, a high pressure piston being secured to the low pressure piston and being arranged axially displaceable in the high pressure  
35 chamber, wherein a pressure gauge is arranged to measure the pressure in the low pressure chamber.

24. Use of a method as claimed in any one of claims  
1-16 or a high pressure pressing device as claimed in any  
5 one of claims 17-23 for treatment of foodstuffs.

25. Use of a method as claimed in any one of claims  
1-16 or a high pressure pressing device as claimed in any  
one of claims 17-23 for treatment of non-food products,  
10 such as pharmaceuticals, cosmetics, soaps and lotions.